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9 HUMAN HEALTH RISKS EVALUATION

9.1 CONCEPTUAL SITE MODEL

A conceptual site model was developed which attempted to link the human health and ecological risk assessments. This was accomplished by illustrating the environmental processes and potential receptors that were thought to represent complete exposure pathways for any substances present in the environment. The conceptual model is intended to provide context for the discussion of study results in Chapters 9 and 10. Figure 9-1 depicts the predicted environmental fate and exposure pathways of substances released by training activities. A brief description of the concepts shown in this figure are provided in the following sections.

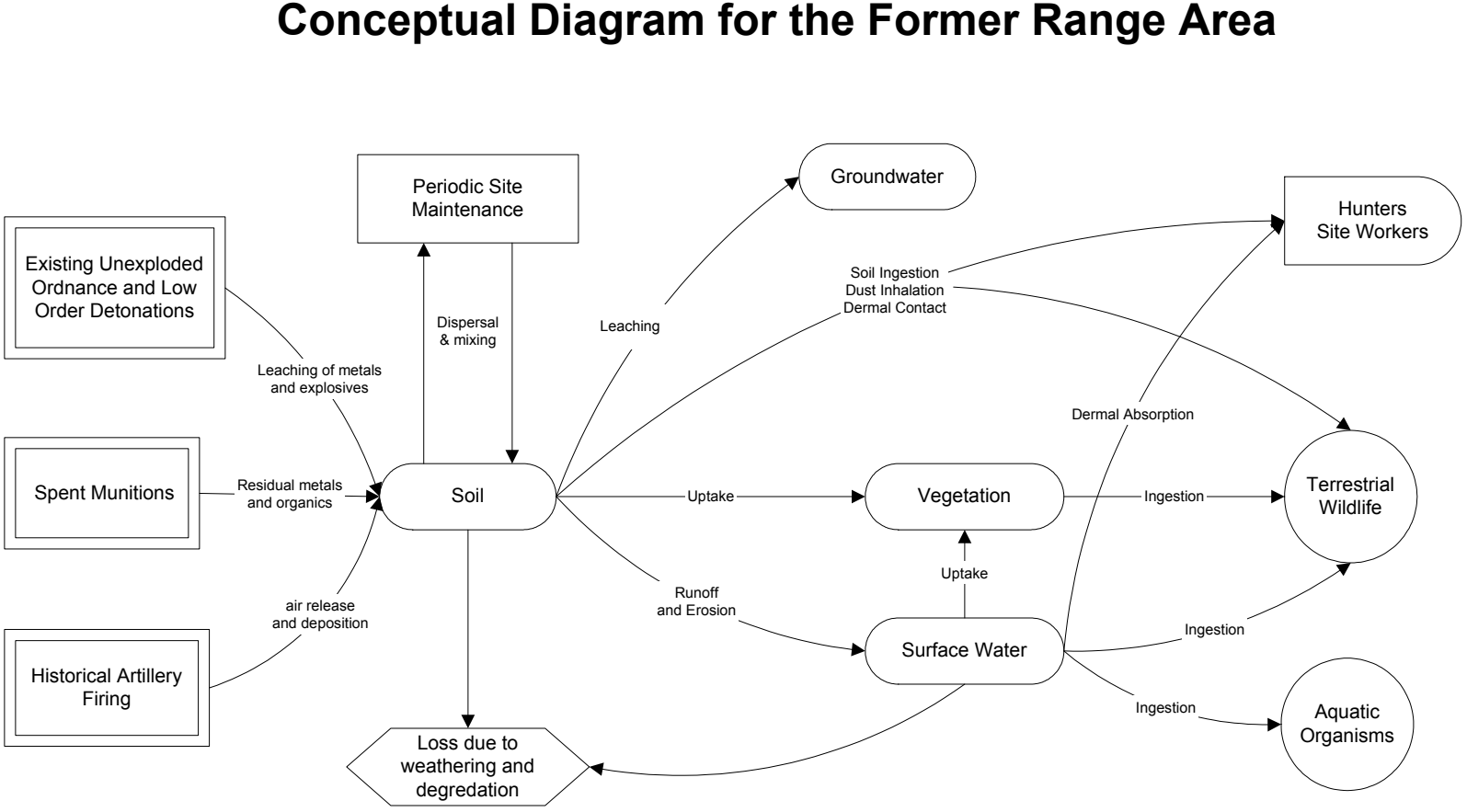
9.1.1 Sources of Substances of Potential Concern (SOPCs)

Since JPG is a closed range, there is not a continuing source of contamination in the range area. Historical artillery firing is the primary source for SOPCs found at the study sites. This would include spent munitions in the impact area, unexploded ordnance (UXO) remaining in the impact area, and aerial release and deposition of chemicals from the weapons historically fired at the firing points. SOPCs may have been distributed in the environment through direct contact with media or air release and subsequent deposition at the firing points or impact area. UXO, particularly those projectiles with compromised integrity, as well as ordnance that produced low-order detonations are thought to be sources of SOPC accumulation in the environment. Where the integrity of the projectile has not been compromised, it is expected that the explosives would be completely contained.

9.1.2 Fate and Transport of SOPCs

SOPCs at the firing points and impact area are thought to accumulate in surface soil where some loss due to weathering and degradation would occur. A portion of the compounds in soil would likely migrate downward in the subsurface soil horizons, and eventually to ground water. Another portion would accumulate in vegetation. Surface water could have been impacted directly by firing, or could receive contamination from soil runoff during rain events.

FIGURE 9-1 GENERAL CONCEPTUAL SITE MODEL



9.1.3 Hypothesized Human and Wildlife Exposure

The primary exposures of humans (i.e., wildlife refuge workers and recreational users) and wildlife to SOPCs are expected to be through soil ingestion, dust inhalation, and dermal contact with substances in soil. Human exposure to chemicals in surface water was evaluated since dermal contact could occur while wading in the various streams. Ingestion of wild game taken from the impact area by hunters is also a potentially complete pathway. However, previous studies addressing bioaccumulation of explosives in deer tissue conducted by USACHPPM (References 1, 2, and 3) concluded that range-related compounds did not tend to accumulate in tissue. Therefore, this pathway was not considered further. Terrestrial wildlife may also be exposed to SOPCs through ingestion of substances accumulated in vegetation. Based on previous artillery range studies, it was expected that there would be little, if any, direct terrestrial impact from the SOPCs evaluated (References 4 and 5).

9.2 DATA QUALITY SCREEN

Causes of variability can be both natural and anthropogenic. Natural variability in soil results from the inherently heterogeneous nature of the original geologic formation, local hydrology, weather, and biotic factors (Reference 6). Anthropogenic variability from uneven treatment or management of an area, and differing land uses, are then superimposed on natural variability (Reference 6). Variability in soil and vegetation samples is discussed in more detail in Chapters 7 and 10.

9.3 SCREENING OF SOPCS

Explosives and metals were the primary analytes for this study. Per USEPA guidance (Reference 7), substances that were detected in fewer than 5% of the samples were not considered further in the risk evaluation based on a low frequency of detection. After this initial evaluation of the data, the following substances were included as SOPCs: antimony, arsenic, barium, chromium, copper, lead, manganese, mercury, molybdenum, nickel, vanadium, RDX, and perchlorate.

9.4 DISTRIBUTION EVALUATION

The distribution of the metals data in soils was evaluated prior to calculating a 95% upper confidence limit (UCL), by pooling data from all the study sites. Duplicate samples were averaged to determine the representative concentration for that area. This resulted in a pooled soil data set of 112 total samples. After consultation with the USACHPPM statistician, nondetect results in soil were included in the data set at the detection limit.

The total data set for soil (n=112) was tested for normality using the Kolmogorov-Smirnov test since the sample sizes were greater than 50. Low significance values, $p<0.05$, indicate that the distribution of the data differs significantly from a normal distribution. Data that did not initially test normal were assumed to be log-normally distributed. In this case, all of the soil analytes tested were found to be non-normally distributed and therefore log-normality was assumed.

9.5 DERIVATION OF EXPOSURE POINT CONCENTRATIONS

The 95% UCL of the arithmetic mean for each substance detected in soil, above background levels, was used as the exposure point concentration. As stated previously, lognormal distributions were assumed for all of the non-normal data which included all analytes in this case. This is a valid statistical approach due to the large sample size available in this case. The central limit theorem indicates that for sample sizes of 50 or greater, the mean of the population will tend to approximate a normal distribution regardless of the distribution of the population overall. In calculating the 95% UCL, nondetect results were treated on a chemical-specific basis. If a chemical only had a few nondetect results, they would have little effect on the resulting exposure point concentration and ½ the detection limit was used as a surrogate value. If the chemical had many nondetects, the value chosen for the nondetected results becomes more significant as it can introduce a bias into the calculated exposure point concentration. RDX was only detected in 23% of the samples collected. Therefore, it was assumed to be present at some level in the other samples. For these, a value equal to the detection limit was used in calculating the exposure point concentration. This may tend to overestimate the true mean but it will provide a degree of conservatism in the resulting value. This approach was developed in consultation with the USACHPPM statistician.

Exposure point concentrations for lognormal data were calculated
by first log-transforming the data and then using the equation provided in the Supplemental *Guidance to RAGS: Calculating the Concentration Term* (Reference 8). The equation is shown below.

$$UCL = e^{(\bar{x} + 0.5x^2 + sH/\sqrt{n-1})}$$

where:

UCL = upper confidence limit
e = constant (base of the natural log)
x = mean of the transformed data
s = standard deviation of the transformed data
H = H-statistic
n = number of samples

The 95% UCLs used in the risk calculations are provided in Table 9-1.

When evaluating exposure, assumed usage patterns by the various receptors were considered. It was assumed that recreational users would be moving over large portions of the site and would therefore average their exposure over the entire study area. Therefore, the entire range area was treated as a single exposure unit when evaluating soil exposure. In contrast, the surface water bodies were evaluated individually for potential health risk. This was done since receptors could be inclined to return to the same area repeatedly (e.g., to a favorite fishing spot). Therefore, instead of averaging their exposure over a large area, as was done with soil, they may be repeatedly exposed to the same chemical concentrations in a specific water body. Since the

sample sizes were limited, the maximum detected concentrations for each chemical in a given stream were used as the exposure point concentrations.

Ground water was sampled as a part of this study as well. However, no complete pathways were identified through which receptors would come in contact with ground water and so it was excluded from the risk screening.

TABLE 9-1 CALCULATED EXPOSURE POINT CONCENTRATIONS - SOIL

Compound	Exposure Point Concentration (mg/kg)
	Impact Area Values
Antimony	1.702
Arsenic	5.225
Barium	98.116
Chromium	10.118
Copper	13.438
Lead	18.183
Maganese	610.546
Mercury	0.031
Molybdenum	0.754
Nickel	4.777
Uranium	4.67
Vanadium	24.162
Perchlorate	0.030
RDX	0.013

9.6 HUMAN HEALTH RISK SCREENING

The previous sections discussing the various environmental media under investigation identified generic screening values that were used as a preliminary evaluation of the data collected during sampling. This comparison provided a context for the concentrations detected, but is not a substitute for a more comprehensive evaluation using site-specific exposure data. The purpose of the human health risk screening is to use site-specific screening values to evaluate the environmental condition of the range with respect to potential human health risk. It should be noted that this evaluation represents an assessment of potential health risk due to exposure to residual compounds in soil and is not intended as an occupational exposure study.

9.7 CHARACTERIZATION OF EXPOSURE SETTING

Section 5 identifies the exposure setting for the JPG.

Due to the nature of the range area, the chance for direct human contact with substances in the environment produced by firing is somewhat restricted. However, hunting and fishing are allowed at times throughout the year on the former range area. Therefore, the main receptors identified in this study are hunters and site workers.

9.8 EXPOSURE ASSESSMENT

An exposure pathway describes the process by which a chemical is transmitted from a source to an exposed population. In general, an exposure pathway must have four elements to be considered complete: a source and mechanism for release, a transport medium, a point for receptors to potentially come in contact with the contaminated medium (exposure point), and an exposure route (e.g., inhalation, ingestion, and dermal absorption) at the point of contact. An exposure pathway must be potentially complete to warrant evaluation in the risk evaluation. For evaluating the former range area at JPG, the complete exposure pathways would consist of the following: incidental ingestion of soil, dermal absorption of chemicals in soil, inhalation of chemicals in windblown dust, and dermal absorption of chemicals in surface water. Risk-based screening levels were developed for each compound detected incorporating each of the previously listed exposure pathways. The screening levels were developed using site-specific parameters that are intended to adequately represent the potentially exposed population. The exposure parameters used are listed in Table 9-2.

TABLE 9-2 EXPOSURE PATHWAY ASSESSMENT VALUES

Pathway	Parameter	Value	Source
Common Values	Exposure Duration	25 years	Reference 10
	Exposure Frequency	50 days/year	Prof. Judgment
	Averaging Time (noncarcinogenic)	Same as Exposure Duration	Reference 7
	Averaging Time (carcinogenic)	70 years	Reference 7
	Body Weight – adults	70 kg	Reference 7
Soil Ingestion	Ingestion Rate	100 mg/day	Reference 10
	Fraction Ingested	1.0	Prof. Judgment
Dermal Absorption (soil)	Surface Area (head, arms, & hands)	3300 cm^2	Reference 10
	Conversion Factor	1E-6 kg/mg	Reference 7
	Adherence Factor	0.2	Reference 10
	Absorption Factor	Chem. Specific	Reference 7
Dust Inhalation	Conversion Factor	1E+3 µg/mg	Reference 7
	Particulate Emission Factor	1.32E+9 m^3/kg	Reference 10
	Inhalation Rate	0.63m^3/hr	Reference 10
Surface Water Absorption	Dermal Permeability Constant	Chemical Specific	Reference 11
	Exposure Time	2 hours/event	Prof. Judgment
	Surface Area	7620 cm^2	Reference 12

9.9 TOXICITY ASSESSMENT

The screening levels were derived based on toxicity data published primarily by the USEPA for use in risk assessment. For the assessment of human health risks from exposure to chemicals, the following three basic toxicity values are of principal importance.

Reference doses (RfDs) for oral exposure – This represents the acceptable chronic daily intake for exposure to a specific chemical. RfDs are intended to be protective of sensitive subpopulations.

Reference concentrations (RfCs) for inhalation exposure – The RfC is analogous to the oral RfD and is likewise based on setting a daily intake that will be without any deleterious health effect. Reference concentrations are expressed in units of mg/m^3 and are converted to inhalation RfDs for use in the screening level equations by multiplying by 20 m^3/day and dividing by 70 kg to obtain units of mg/kg-day.

Cancer Slope Factors (CSFs) – For both oral and inhalation exposure routes. The slope factor is the cancer risk (proportion affected) per unit of dose. The slope factor is expressed on the basis of chemical weight $[(mg/kg/day)^{-1}]$.

The primary source of toxicity information is the USEPA's Integrated Risk Information System (IRIS). If values are not available in IRIS, the Health Effects Assessment Summary Tables (HEAST), or the USEPA Region 9 Preliminary Remediation Goals (PRGs) Table were consulted.

USEPA recommends two different approaches for evaluating noncarcinogenic and carcinogenic health effects. The two approaches reflect the fundamental difference in the proposed mechanism of toxic action. In assessing the potential for noncancer health effects, USEPA assumes that there is a toxicologic threshold below which no adverse health effects occur. These toxicological thresholds are represented by RfDs for oral exposures and RfCs for inhalation exposures. No values have been developed for dermal exposures so the oral RfD is used to evaluate this route of exposure. The RfD represents an average daily intake expressed in units of (mg/kd*day).

For carcinogens, the threshold response level is believed to be inappropriate. CSFs are developed with the idea that cancer risk is linearly related to dose. Therefore, even though most of the cancer data obtained from laboratory animal studies are for relatively high doses, it is assumed that these doses can be extrapolated down to the extremely small doses that would be expected from environmental exposure. This nonthreshold theory assumes that even a single molecule of a carcinogen may cause changes in a single cell that could result in the cell dividing in an uncontrolled manner and eventually lead to cancer. It should be pointed out that this method leads to a plausible upper limit of cancer risk, but does not necessarily give a realistic prediction of the true risk.

The carcinogenic potency of a substance depends, in part, on its route of entry into the body. Therefore CSFs are classified, like RfDs, according to the route of administration (i.e., inhalation, ingestion). Ideally, route-specific CSFs should be used to evaluate the carcinogenic risk posed by each carcinogen through each exposure route of concern. However, only a limited number of CSFs have been developed and may exist for only one route of exposure. The oral slope factor is presented as the risk per mg/kg-day. For inhalation, a unit risk factor is provided that is a quantitative estimate in terms of risk per ug/m^3 of air breathed for adults. For use in the screening level equations, this is converted to an inhalation CSF by dividing by 20 m^3/day and multiplying by 70 kg in order to obtain units of $(mg/kg*day)^{-1}$. Dermal CSFs have not been derived for any chemicals so the oral value was used instead. The USEPA has developed a classification system which indicates the likelihood that a particular chemical is a human

carcinogen based on a weight-of-evidence (WOE) judgment using human and animal evidence. This classification system is described below.

A – Human carcinogen.
B1 – Probable human carcinogen – limited evidence of human carcinogenicity.
B2 – Probable human carcinogen – sufficient animal evidence and inadequate human data.
C – Possible human carcinogen – limited evidence in animals and no human data.
D – Not classified as to carcinogenicity.
E –- No evidence for carcinogenicity.

Screening levels were calculated separately for non-cancer and cancer effects for each compound. Whichever value was more stringent was then chosen as the screening level for that particular compound. The toxicological reference values used are listed in Table 9-3.

9.10 SCREENING LEVEL DERIVATION

To develop risk-based screening levels, values describing the extent, frequency, and duration of the exposure are combined with target risk values and toxicity information in order to back-calculate an environmental concentration that represents a safe level. The equations used in calculating screening levels were derived from standard USEPA intake equations. Table 9-3 presents the values used for the various intake parameters. These values are based on a combination of USEPA default values and site-specific information where appropriate.

9.10.1 Exposure Parameters

When available, exposure parameters were first chosen from site-specific information, then from the USEPA's Supplemental Guidance for Developing Soil Screening Levels (Reference 10), Dermal Exposure Assessment (Reference 11), Risk Assessment Guidance for Superfund (RAGS) (Reference 7), or finally the Exposure Factors Handbook (Reference 12). Many of the parameters used in RAGS vary according to the general default conditions. Variability in parameter selection is a source of uncertainty in this methodology.

The following discussion lists the criteria and justification for selecting the individual exposure parameters. The source of the value for each variable is described. Additionally, the exposure-specific values chosen are explained.

TABLE 9-3 TOXICITY REFERENCE VALUES

Compound	RfD(oral) (mg/kg*day)	Source	RfD(inh) (mg/kg*day)	Source	CSF(oral) $(mg/kg*day)^{-1}$	Source	CSF(inh) $(mg/kg*day)^{-1}$	Source	WOE
Antimony	4.00E-04	IRIS	na	na	na	na	na	na	na
Arsenic	3.00E-04	IRIS	na	na	1.50E+00	Iris	1.50E+01	REG9	A
Barium	7.00E-02	IRIS	1.40E-04	HEAST	na	na	na	na	D
Cadmium	5.00E-04	IRIS	na	na	na	na	6.30E+00	Iris	B1
Chromium	3.00E-03	IRIS	2.20E-06	REG9	na	na	2.90E+02	REG9	A
Copper	4.00E-02	HEAST	na	na	na	na	na	na	D
Lead	na	na	na	na	na	na	na	na	na
Manganese	2.40E-02	IRIS	1.45E-05	IRIS	na	na	na	na	D
Mercury	8.60E-05	IRIS	na	na	na	na	na	na	na
Molybdenum	5.00E-03	IRIS	na	na	na	na	na	na	na
Nickel	2.00E-02	IRIS	na	na	na	na	na	na	na
Silver	5.00E-03	IRIS	na	na	na	na	na	na	D
Uranium	2.00E-04	NCEA	na	na	na	na	na	na	na
Vanadium	9.00E-03	IRIS	na	na	na	na	na	na	na
Zinc	3.00E-01	IRIS	na	na	na	na	na	na	na
Perchlorate	1.00E-04	w - IRIS	na	na	na	na	na	na	na
RDX	3.00E-03	IRIS	3.00E-03	R.Ext.	1.10E-01	IRIS	1.10E-01	R.Ext.	C

Sources: IRIS – USEPA Integrated Risk Information System; HEAST – Health Effects Summary Tables; W-IRIS – withdrawn from IRIS; REG 9 – USEPA Region 9 Preliminary Remediation Goals Table; NCEA – USEPA National Center for Environmental Assessment Provisional Value.

9.10.1.1 Exposure Frequency and Duration (EF and ED)

Exposure frequency is site-specific and defined as a measure of the expected number of days per year that a person is exposed (Reference 7). Exposure duration is the expected number of years a person will most likely be exposed. The EF and ED can vary between 0 to 365 days per year and 0 to 70 years, respectively. For the receptors evaluated in this study, soil screening values were calculated based on an exposure frequency of 50 days per year and an exposure duration of 25 years. These were based on professional judgment and should provide a conservative evaluation of potential risk.

9.10.1.2 Non-carcinogenic Averaging Time (AT)

Averaging time is the value used to average exposures over a person's exposure duration (non-carcinogenic) or lifetime (carcinogenic). For the non-carcinogenic evaluation, averaging time is equal to the exposure duration. This value can vary from 0 to 70 years. For this risk screening, the averaging time was 25 years.

9.10.1.3 Carcinogenic Averaging Time (AT)

For the cancer evaluation, averaging time is equal to an average lifespan of 70 years. This value does not vary.

9.10.1.4 Body Weight (BW)

Body weight refers to a person's weight in kilograms. The recommended value is 70 kg for adults, ages 18-75 years (Reference 7).

9.10.1.5 Soil Ingestion Rate (IRS)

The soil ingestion rate recommended by the USEPA for adults in an industrial setting is 100 mg/day (Reference 10).

9.10.1.6 Dermal Surface Area Available for Absorption (SA)

Dermal surface area available for absorption is the amount of skin area that could come in contact with a contaminated surface. The range of possible values was obtained from USEPA guidance (Reference 10). It was assumed that a receptor's arms, hands, and head would be susceptible to soil exposure. The value for males was used since it is larger than that of females and, therefore, provides a conservative estimate. For surface water exposure, it was assumed that the lower extremities would be in contact with water while wading. Therefore, the value for surface area of adult male lower extremities was used as provided in the USEPA's Exposure Factors Handbook (Reference 12).

9.10.1.7 Soil Adherence Factor (AF)

The soil adherence factor refers to the ability of the soil to adhere to the skin surface therefore allowing chemicals in the soil to be dermally absorbed. The USEPA recommended value of 0.2 (mg/cm^2-event) for adults in a commercial/industrial scenario was used (Reference 10).

9.10.1.8 Dermal Absorption Factor (ABS)

The dermal absorption factor is a chemical-specific constant that indicates the relative efficiency of dermal absorption into the skin from a particular substance. The USEPA Region 9 PRG table (Reference 13) was the source for the dermal absorption factors used in this evaluation. Table B-1 in Appendix B lists the specific values used for each substance.

9.10.1.9 Particulate Emission Factor (PEF)

The particulate emission factor is a measure of the area of land necessary to emit a given mass of dust particulates. The supplemental soil screening guidance (Reference 10) presents an equation for calculating a site-specific value. However, due to the large number of variables involved, it is impractical to calculate a site-specific PEF for the entire range. Therefore, a default value presented in the guidance was used in calculating the soil screening levels.

9.10.1.10 Inhalation Rate (IR)

Inhalation rate is a measure of the amount of air a person inhales each day. The USEPA recommends several adult inhalation rates depending on activity level. The moderate activity adult inhalation rate of 20 m^3/day was used for this evaluation (Reference 7).

9.10.1.11 Exposure Time (ET)

The exposure time represents the average time a receptor would be expected to spend in contact with surface water during each event. The value of 2 hours was chosen based on professional judgment.

9.10.1.12 Dermal Permeability Constant (PC)

This value represents the ability of chemicals in water to move through the skin. Values are presented in the USEPA's dermal exposure assessment guidance

(Reference 11) on a chemical-specific basis. Since none of the metals were specifically listed in this reference, the surrogate value of $1X10^{-3}$ was used as recommended. For RDX, a value was calculated using the following equation (1).

(1)

$$\log K_p = -2.72 + 0.71 \log K_{o/w} - 0.0061 MW$$

Where:

K_p= Dermal Permeability Constant (cm/hour)
log $K_{o/w}$= Octanol Water Partition Coefficient
MW = Molecular Weight

For RDX, a K_p value of $3.5X10^{-4}$ was calculated using an MW of 222.26 g/mol and a log $K_{o/w}$ of 0.87.

Equations (2) and (3) calculate screening levels for all three pathways associated with soil exposure (ingestion, dermal absorption, dust inhalation). If toxicological reference values were not available for certain pathways, the terms evaluating that pathway in the denominator were removed. Screening levels were derived based on a hazard index (HI) of 1.0 and an excess cancer risk level of 1.0E-5.

Non-Carcinogenic Level

(2)

$$ScreeningLevel(mg/kg) = \frac{THQ * BW * AT}{EF * ED[(\frac{1}{RfD_o} * \frac{IRS}{10^6}) + (\frac{1}{RfD_o} * \frac{SA * AF * ABS}{10^6}) + (\frac{1}{RfD_i} * \frac{IR}{PEF})]}$$

Carcinogenic Level

(3)

$$ScreeningLevel(mg/kg) = \frac{TR * BW * AT}{EF * ED[(CSF_o * \frac{IRS}{10^6}) + (CSF_o * \frac{SA * AF * ABS}{10^6}) + (\frac{IR * CSF_i}{PEF})]}$$

Where:

THQ = Target Hazard Quotient
TR = Target Cancer Risk Level
BW = Body Weight (kg)
AT = Averaging Time (days)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
RfD_o = Oral Reference Dose (mg/kg*day)
IRS = Soil Ingestion Rate (mg/day)
SA = Skin Surface Area (cm^2/event)
AF = Soil Adherence Factor (mg/cm^2)
ABS = Absorption Factor (unitless)
CSF_o = Oral Cancer Slope Factor $(mg/kd*day)^{-1}$
IR = Inhalation Rate (m^3/hour)
RfD_i = Inhalation Reference Dose (mg/kd*day)
CSF_i = Inhalation Cancer Slope Factor $(mg/kd*day)^{-1}$
PEF = Particulate Emission Factor (m^3/kg)

Equations (4) and (5) were derived to calculate screening levels for dermal exposure to chemicals in surface water.

Non-Carcinogenic

(4)

$$ScreeningLevel(\mu g/L) = \frac{THQ * BW * AT}{EF * ED * ET[\frac{1}{RfD_o} * SA * PC * CF]}$$

Carcinogenic

(5)

$$ScreeningLevel(\mu g/L) = \frac{TR * BW * AT}{EF * ED * ET[CSF_o * SA * PC * CF]}$$

Where:

THQ = Hazard Quotient
BW = Body Weight (kg)
AT = Averaging Time (days)

EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
ET = Exposure Time (hours/event)
RfD_o = Oral Reference Dose (mg/kg*day)
SA = Skin Surface Area (cm^2)
PC = Permeability Constant (cm/hour)
CF = Conversion Factor (µg/mg)
TR = Target Risk
CSF_o = Oral Cancer Slope Factor $(mg/kd*day)^{-1}$

9.11 LEAD

An exception to this general process of risk screening is inorganic lead. Quantifying lead's potential health risk involves many uncertainties, some of which may be unique to lead. Age, health, nutritional state, body burden, and exposure duration influence the absorption, release, and excretion of lead. In addition, current knowledge of lead pharmacokinetics indicates that an estimate derived by standard procedures would not truly describe the potential risk (Reference 14). As a result, the existing Region 9 Preliminary Remediation Goal (Reference 13) for lead was used in this risk evaluation to approximate the recreational and site worker exposure.

9.12 EXPOSURE POINT CONCENTRATIONS

As discussed in Section 9.5, the 95%UCL of the mean was used as the exposure point concentration of each substance detected in soil. A single set of exposure point concentrations was calculated to represent the entire range area. In cases where a large degree of variability in the data caused the 95^{th} UCL to be greater than the maximum detection, the maximum value was used instead of the 95^{th} UCL. For the surface water evaluation, the maximum detected values were used for the screening due to the small size of the dataset.

9.13 DATA EVALUATION

Once the screening levels were developed and the exposure point concentrations were calculated, the risk screening simply consisted of directly comparing the two values. Tables 9-4 and 9-5 present the SOPCs along with their respective exposure point concentrations and site-specific screening values. This evaluation was conducted for the range area soils, and for surface water on an individual stream basis.

TABLE 9-4 IMPACT AREA SOILS RISK SCREENING

Compound	Exposure Point Concentration (mg/kg)	Site-Specific Screening Value (mg/kg)
Antimony	1.70	1706.18
Arsenic	5.23	79.62
Barium	98.12	297827.62
Chromium	10.12	12708.66
Copper	13.44	170617.70
Lead	18.18	750*
Maganese	610.55	101520.54
Mercury	0.03	366.83
Molybdenum	0.75	21327.21
Nickel	4.78	85308.85
Vanadium	24.16	38388.98
Perchlorate	0.03	307.83
Uranium	4.67	853.1
RDX	0.01	783.57

*Generic USEPA Region 9 Industrial PRG (Reference 13)

As this table indicates, none of the substances detected in soil in the impact area are present at levels that exceed the site-specific screening values. Therefore, exposure to impact area soils should not pose a health risk to humans under the conditions evaluated in this assessment.

TABLE 9-5 SURFACE WATER RISK SCREENING

	Marble Creek	Middle Creek	Big Creek	Otter Creek	Graham Creek	Little Graham Creek	Screening Level
Compound	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Antimony	0.0599	0.0937	0.0861	0.0957	0.13	0.0957	13412.1
Arsenic	0.688	0.572	0.917	1.16	1.53	1.16	625.9
Barium	78.5	122	55.2	65.3	58.4	122	2347112.9
Cadmium	0.0148	0.101	0.0322	0.136	0.0231	0.136	16765.1
Chromium	Nd	0.358	0.462	0.522	0.575	0.522	100590.6
Copper	0.698	5.52	1.46	1.18	1.27	5.52	1341207.3
Lead	0.154	0.0977	1.46	0.188	0.373	1.46	na
Manganese	120	251	113	78.8	99.4	251	804724.4
Mercury	0.00234	0.00174	0.00364	0.00228	0.00313	0.00364	2883.6
Molybdenum	0.403	0.673	0.493	1.65	1.33	1.65	167650.9
Nickel	1.65	3.7	2.07	2.43	2.46	3.7	670603.7
Silver	0.014	0.0467	0.0264	0.043	0.105	0.0467	167650.9
Uranium	0.236	0.636	4.08	1.11	0.58	4.08	6706.0
Vanadium	0.303	0.326	1.34	0.707	1.22	1.34	301771.7
Zinc	1.26	12.5	3.68	2.18	1.59	12.5	10059055.1
RDX	0.027	0.19	0.14	0.023	0.13	0.19	287401.6

As this table indicates, all of the maximum detections of chemicals in surface water are well below the site-specific screening levels. This indicates that there would not be an unacceptable risk to recreational users wading in streams under the conditions described in the exposure assessment.

9.14 UNCERTAINTY

The process of evaluating risk uses principles drawn from many scientific disciplines, including chemistry, toxicology, physics, mathematics, and statistics. Because the data sets used in the calculations are incomplete, many assumptions are required. Therefore, calculated risk screening values contain inherent uncertainties. However, the majority of the estimates used are biased toward being conservative in an attempt to ensure that the resulting values are slightly overprotective of human health.

9.14.1 Exposure Assessment

While the use of the former range area is generally understood in terms of the types of activities that receptors would engage in, there is still uncertainty in the assumptions made regarding frequency of exposure, and the specific intake parameters. Values are chosen for variables such as body weight and skin surface area that are meant to be conservative. For most receptors, this will result in an overestimation of risk. However, an individual could exceed the values used and would therefore represent a higher potential risk than estimated in the assessment.

9.14.2 Toxicity Assessment

The derivation of toxicity values is also a source of uncertainty. Most of the data on health effects comes from animal studies. USEPA collects and evaluates all known studies for each chemical. The most sensitive animal and the adverse effect which occurs at the lowest dose is then used to derive, by the application of uncertainty and modifying factors, the RfD for noncarcinogens. Humans are assumed to be even more sensitive than the most sensitive animal. The health effect in humans may not be the same, but human data is sought to corroborate the animal data. The same data evaluation process takes place for carcinogens, but the data is extrapolated to humans by using the 95% UCL of the mean slope from the primary study used to derive the CSF. Since the screening values are based on the available toxicological reference values, this uncertainty is carried through into the risk evaluation.

9.15 SUMMARY

Environmental field sampling conducted within the former firing points and impact areas at JPG indicated several metals and explosives were present in site soils. The substances detected in a relatively high percentage of the samples were antimony, arsenic, barium, cadmium, chromium, copper, lead, manganese, mercury, molybdenum, nickel, silver, urantium, vanadium, perchlorate, and RDX. Using the sampling data collected, the 95% UCL of the arithmetic mean was calculated for each substance. These values were used as exposure point concentrations to represent average conditions that an individual may be exposed to over the entire site. Site-specific risk-based screening values were then derived and the risk evaluation was performed by

comparing these with the exposure point concentrations for each substance. Screening levels were also derived evaluating dermal absorption of chemicals in surface water. A risk screening for surface water was conducted in a similar manner except the maximum detections of each compound were used as the exposure point concentrations. Each stream was evaluated separately since they could represent discrete areas of exposure.

9.16 CONCLUSIONS

Based on the data collected during sampling, the SOPC's detected in both soil and surface water within the former range area would not be expected to present a health risk to site workers or recreational users (hunters). All of the exposure point concentrations evaluated were well below the calculated site-specific screening levels.

9.17 REFERENCES

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